DESIGN OF THREE-STOREY CIVIL ENGINEERING BUILDING: LIBRARY, LABORATORY, AND MULTI-PURPOSE HALL WITH SOLAR PANELS AT LA CONCEPCION COLLEGE P.E. GROUNDS, KAYPIAN

A Quantitative Research Presented to the

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In Partial Fulfillment of the Requirements for the Degree

Bachelor of Science in Civil Engineering

Major in Construction Engineering

and Management

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RECOMMENDATION

This is to certify that this research entitled "DESIGN OF THREE-STOREY CIVIL ENGINEERING BUILDING: LIBRARY, LABORATORY AND MULTI- PURPOSE HALL WITH SOLAR PANELS AT LA CONCEPCION COLLEGE P.E. GROUNDS, KAYPIAN", prepared and submitted by Rey Vincent A. Gutlay, Ronald V. Ribo Jr., Marielle Zhaira D. Turla, has been examined and PASSED the PRE-ORAL DEFENSE.

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CERTIFICATE OF ORIGINALITY

This certificate hereby verifies that the researchers originally made this and that no research has been previously written or published by another person or organization, not even any awards and recognition materials from other colleges and universities or other tertiary learning institutions have been asserted hereto, except where due acknowledgment is made thereof.

Furthermore, we declare that the intellectual content of this research is the product of our thorough endeavors, harnessing fresh ideas from the group and using simple language and a clear writing style, as can be observed in our representation.

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CHAPTER 1

The Problem and Its Background

This chapter provides an overview of the study, including the introduction, theoretical and conceptual frameworks, the statement of the problem, the hypotheses, the scope and limitations of the study, the significance of the study, and definitions of terms.

Introduction

Education does not revolve solely around four walls but also requires facilities that promote practical learning and participation in real-world applications. The library and laboratories provide students with the resources and hands-on experiences necessary for in-depth learning and critical thinking. Edelytics (2025). The library offers a wide range of learning facilities to access additional knowledge, experiences, and books. Adding a functional laboratory provides us with equipment and facilities to perform controlled experiments, especially in civil engineering, such as soil, steel, and concrete testing.

La Concepcion College provides aspiring Civil Engineering students with air-conditioned classrooms and accessible facilities. With the continued growth of the department and the number of students, this required additional learning facilities, such as study areas or workplaces that cater to every student's needs while remaining economical. To address these concerns, the researcher conducted a study with a title

of "Design of Three-Storey Civil Engineering Building: Library Laboratory and Multi-Purpose Hall with Solar Panels at La Concepcion College P.E. Grounds, Kaypian", which will contain proposed architectural design and structural plans on creating a three-storey building with a solar panel as an alternative source of power. On the first floor will be a multi-purpose hall that provides a flexible space for officers, such as Academic Affairs, and students to hold seminars, meetings, gatherings, and extracurricular activities, as well as a faculty area with professors' own space. On the other hand, the second floor will be a computer laboratory where students can improve their design skills using software, as well as a library for accessible reference.

Meanwhile, the third floor houses the physics-chemistry and hydraulics-geotechnical laboratories, which are essential to education and where students gain hands-on experience across all major subjects. Solar panels that generate power for the campus will gradually reduce electricity bills while also supplying power to every room. This will reduce the campus's carbon footprint and promote sustainability. The study covered the structural and architectural considerations of the building design, ensuring compliance with the National Building Code of the Philippines (NSCP) safety standards, environmental sustainability, and cost-effectiveness.

Background of the study

In the civil engineering building of La Concepcion College, the existing facilities pose challenges that affect students' convenience. The computer laboratory is located at the third campus, while the teaching room is established at the CE building. Meanwhile, the hydraulics/geotechnical laboratory usually has machines and

equipment available to learners. Still, the current space has only a whiteboard, similar to the physics and chemistry lab, with fewer testing materials. This institution depends solely on one energy source and has no backup in case of failure; this can disrupt teaching, especially for professors using projectors, computers, and online resources.

It makes the environment uncomfortable and reduces safety, especially for faculty who cannot operate without electricity. In the early stage, it helps the tutee by providing an accessible, physical place. Learners in this study were specifically asked whether the layout of spaces in the Chamberlain Student Center positively or negatively affected them compared to other buildings and outdoor spaces on campus. This study, using a suitable backup energy, influences education,

Using a solar panel as an alternative backup power source to develop a sustainable, cost-efficient electric supply was effective for the institution. This research seeks to develop these building designs to engage students in real-world applications by providing a functional laboratory and a multi-purpose hall that support their studies. The alternative use of backup energy also impacts the institution, offering cost savings and reducing reliance on electricity.

Theoretical Framework

The researchers connect these theories and concepts related to design, load-bearing Capacity, Source of energy, and facilities for the current study.

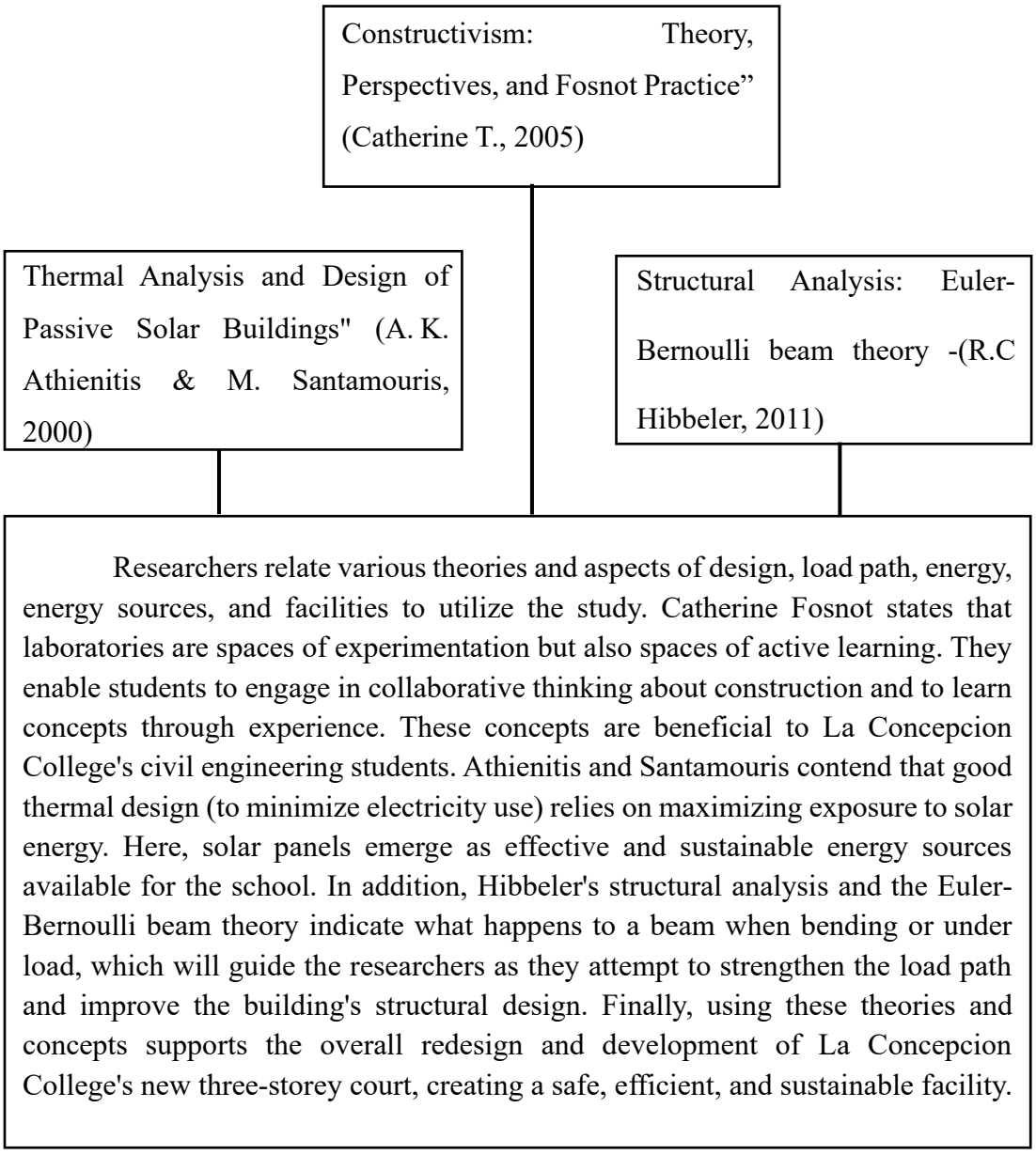
Constructivism: Theory, Perspectives, and Fosnot Practice" (Catherine T., 2005)
Thermal Analysis and Design of Passive Solar Buildings" (A. K. Athienitis & M. Santamouris, 2000)
Structural Analysis: Euler-Bernoulli beam theory -(R.C Hibbeler, 2011)
Researchers relate various theories and aspects of design, load path, energy, energy sources, and facilities to utilize the study. Catherine Fosnot states that laboratories are spaces of experimentation but also spaces of active learning. They enable students to engage in collaborative thinking about construction and to learn concepts through experience. These concepts are beneficial to La Concepcion College's civil engineering students. Athienitis and Santamouris contend that good thermal design (to minimize electricity use) relies on maximizing exposure to solar energy. Here, solar panels emerge as effective and sustainable energy sources available for the school. In addition, Hibbeler's structural analysis and the Euler-Bernoulli beam theory indicate what happens to a beam when bending or under load, which will guide the researchers as they attempt to strengthen the load path and improve the building's structural design. Finally, using these theories and concepts supports the overall redesign and development of La Concepcion College's new three-storey court, creating a safe, efficient, and sustainable facility.

Figure 1: *The theoretical framework illustrates theories from different studies.*

Conceptual Framework

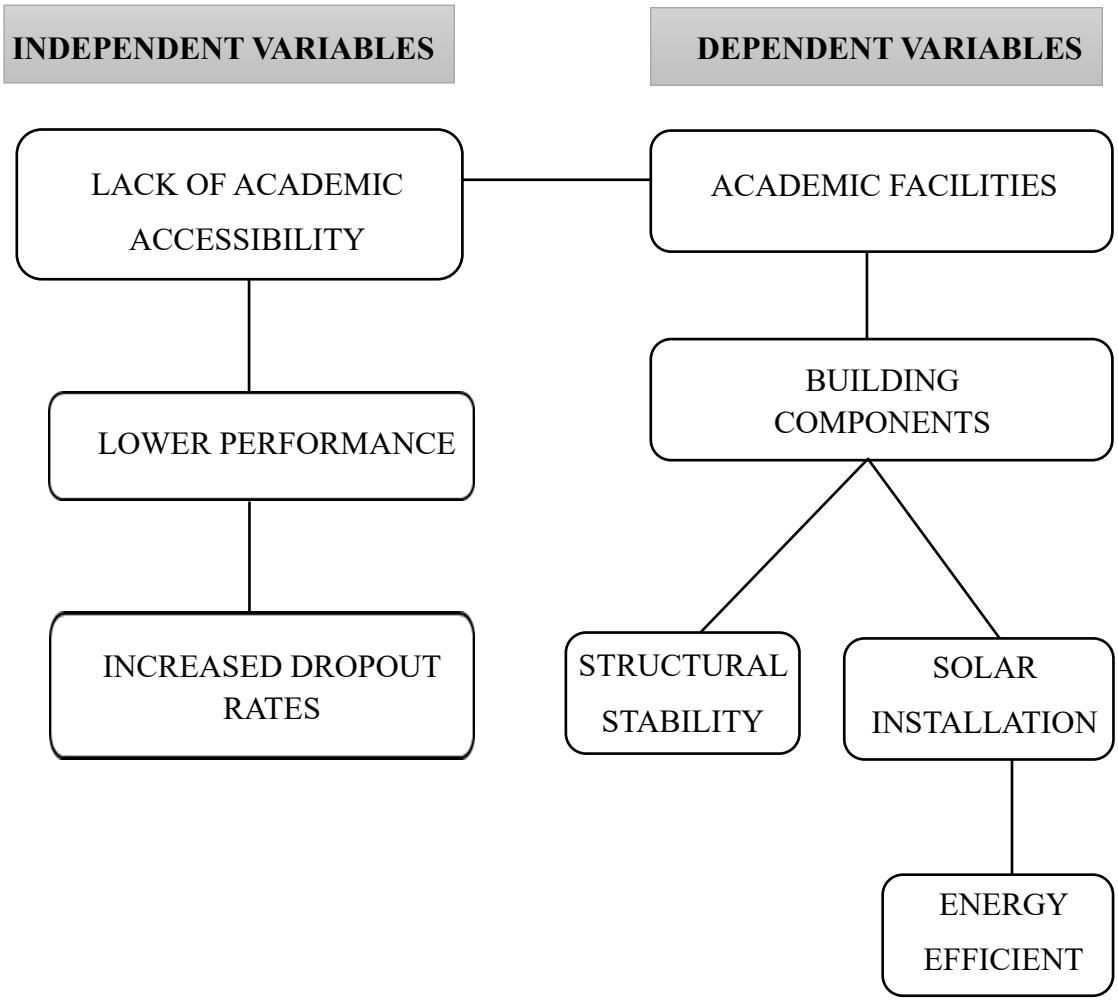

Figure 2: *The conceptual framework*

IPO Conceptual Framework

INPUT	PROCESS	OUTPUT
1. Demographic Profile of Respondents: 1.1 Age 1.2 Sex 1.3 Role in the Civil Engineering Department 2. How can the structural system of the proposed Civil Engineering Building resist the maximum capacity load in respect of dead load, live load, wind load, and seismic load? 2.1 Compliance to the National Structural Code (NSCP) of the Philippines 2.3 The stability and safety factor of beams, columns, slabs, and foundations 2.3 Structural failure resistance 3. How could the multi-purpose hall, labs, and library maximize their usable floor areas? 3.1 Compliance with each class size and the space requirement 3.2 Usability, comfort, and accessibility of students and faculty to utilize 3.3 Efficient use of the overall facility area for lab	● Perform structural analysis using NSCP load combinations to verify stability, safety, and resistance to failure. ● Design the structural system to ensure safety, stability, and durability based on analysis results. ● Evaluate material performance under environmental and seismic conditions to estimate service life. ● Prepare layouts that follow space standards and promote comfort, functionality, and efficient use of area. ● Assess the overall design for accessibility, safety, functionality, and convenience for the Civil Engineering department. ● Create architectural	

and classroom experiments 4. How is solar panel integration in the proposed Civil Engineering building better than traditional energy systems in terms of: 4.1 Construction schedule and maintenance requirements 4.2 Cost savings in terms of energy consumption and operating expenditures 4.3 Dependability and energy efficiency in powering facility and laboratory operations 5.How does the given structural design facilitate the establishment of the Civil Engineering department in relation to: 5.1 Accessibility of facilities for faculty and students 5.2 Convenience and safety during normal use	floor plans and layouts in AutoCAD for classrooms, laboratories, and the multi-purpose hall. ● Prepare a detailed cost estimate covering materials, labor, and other provisions to confirm financial feasibility.	

Table 1: *IPO Conceptual Framework*

Statement of the problem

The current Civil Engineering building at La Concepcion College, Kaypian, lacks space, safety features, and proper facility design. These problems limit its use and affect the quality of learning and teaching. With the growing student population, the need for larger, safer, and more functional spaces continues to rise. This study proposes the structural design of a three-storey Civil Engineering building equipped with chemistry-physics laboratories, computer laboratory, hydraulics-geotechnical laboratory, faculty rooms, and a multi-purpose hall. The goal is to create a secure and efficient academic facility that supports hands-on learning, research, and institutional development.

Furthermore, the researchers seek to answer the following questions:

1. Demographic Profile of Respondents:
   1.1 Age
   1.2 Sex
   1.3 Role in the Civil Engineering Department
2. How can the structural system of the proposed Civil Engineering Building resist the maximum capacity load in respect of dead load, live load, wind load, and seismic load?
   2.1 Compliance to the National Structural Code (NSCP) of the Philippines
   2.3 The stability and safety factor of beams, columns, slabs, and foundations
   2.3 Structural failure resistance

3. How could the multi-purpose hall, labs, and library maximize their usable floor areas?

   3.1 Compliance with each class size and the space requirement

   3.2 Usability, comfort, and accessibility of students and faculty to utilize

   3.3 Efficient use of the overall facility area for lab and classroom experiments

4. How is solar panel integration in the proposed Civil Engineering building better than traditional energy systems in terms of:

   4.1 Construction schedule and maintenance requirements

   4.2 Cost savings in terms of energy consumption and operating expenditures

   4.3 Dependability and energy efficiency in powering facility and laboratory operations

5. How does the given structural design facilitate the establishment of the Civil Engineering department in relation to:

   5.1 Accessibility of facilities for faculty and students

   5.2 Convenience and safety during normal use

Objectives of the study

This study aims to develop a design proposal for a new three-storey Civil Engineering building at La Concepcion College, Kaypian, in response to the current facility's lack of space, laboratories, and proper functional design. The proposed building will include laboratories (chemistry-physics, computer, and hydraulics-geotechnical), faculty rooms, and a multi-purpose hall to accommodate the growing student population. This study aims to provide a safe, spacious, and well-equipped academic environment that enhances the quality of teaching, supports hands-on learning and research, and promotes the overall development of the institution.

Specifically, the objectives of this research are as follows:

1. To assess the demographic profile of the respondents:
2. To evaluate the maximum load capacity of the proposed three-storey Civil Engineering building based on NSCP (2015).
3. To determine the effectiveness of space design in promoting comfort and functionality for student and faculty.
4. To assess the impact of solar panels integration in the building design, considering the budget cost and energy efficiency.
5. To determine the influence of the building design on CE division in terms of accessibility, safety, and functionality.

Research Hypothesis

H_O: The design of a three-storey structure with a solar panel has no significant relationship in terms of its effectiveness and functionality as a library, laboratory, and multi-purpose hall.

H_a: The design of a three-storey structure with a solar panel has a significant relationship in terms of its effectiveness and functionality as a library, laboratory, and multi-purpose hall.

Significance of the study

This study will benefit the following:

Student: This study will benefit the student by providing space and opportunities for in-depth, hands-on learning through the library and laboratories. A multi-purpose hall as a facility for seminars, tutoring, meetings, etc., that will enhance students' learning.

Faculty and staff: This study will benefit faculty and staff by providing a functional workspace where they can properly demonstrate lessons and modernize teaching in a comfortable environment.

La Concepcion College: This study will support the school's continued growth by providing additional learning facilities. With solar panels, electricity costs may decrease, benefiting the school and students.

Future Researcher: This study will serve as a reference for future academic research related to sustainable building design and educational infrastructure

development. It can guide future researchers in designing a school building with solar panels.

Scope and limitation

This study focuses on the design of a three-storey Civil Engineering building at La Concepcion College Court, Regina Heights, Kaypian, which will include a library, laboratory, and multi-purpose hall. The design uses a solar panel partially to power the building. The study covers the architectural, structural, and engineering design, cost estimate, and timeline for a three-storey building with a library and multi-purpose hall on the first floor. On the second floor, Chemistry-Physics, Geotechnical-Hydraulics, and Computer Laboratory, with three bathrooms for men, women, and faculty. The building uses solar panels to reduce electricity consumption. Presentation of design outputs in 2D and 3D software, as well as miniature that demonstrate functionality, safety, and sustainability.

This study covers only the architectural, structural, engineering design, cost estimate, and schedule of the three-storey building. It excludes plumbing design, electrical plan, actual implementation, construction phases, and long-term performance analysis of the building and the solar energy system. This study is also limited to La Concepcion College P.E. Grounds. It cannot be applied directly to other institutions or areas with different land conditions, available space, or building requirements.

Definition Of Terms

Budget and Cost - It is the estimated financial requirement for the design, materials including the solar panels for the academic facility.

Building Orientation - In this study, this refers to the positioning of the building in relation to the sun's path to maximize solar panel efficiency and natural lighting.

Dead Load – It refers to the weight of the three-storey building itself, including the beams, columns, slabs, and other fixed-position structure elements that act permanently on the building.

Laboratory - In this study, there are three different laboratories: chemistry-physics laboratory, hydraulics-geotechnical laboratory, and computer laboratory, where students will conduct hands-on activities for the study.

Library - In this study, the library is where the past civil engineering students' theses or research can be seen. This is also where the dedicated books and learning materials for the said program can be found. In addition, this will give students more room to study.

Live Load – In this study, it refers to the weight that can change position over time , such as students, faculty, laboratories, books, and other furniture.

Load Bearing Capacity - In this study, it is the maximum load of the building without experiencing failure.

Multi-purpose Hall - This refers to the space where Academic affairs, officers, and faculty can conduct their tutoring sessions, as well as meetings, orientations, seminars, and other events.

National Building Code of the Philippines - The set of regulations and standards for design, safety, and construction used in this study.

Natural Lighting - In this study, natural lighting refers to the use of sunlight to illuminate the interior spaces, reducing dependence on artificial lighting and contributing to energy efficiency.

Seismic Load - The forces exerted on the building during an earthquake, which must be accounted for in the design to ensure safety.

Site Condition -the physical state where the construction takes place.

Soil Stability – The capacity of soil to resist failure under load and erosion from wind and water, ensuring safe and stable design of the foundation.

Solar Panel (Photovoltaic Module) - In this study, this device converts sunlight into electrical energy, serving as an alternative power supply for the building.

Three-Storey Building - In this study, this refers to a building with floors consisting of laboratories, a library, and a multi-purpose hall

Ventilation - In this study, ventilation refers to the in-and-out movement of fresh air in the proposed building, especially in enclosed rooms like laboratories and the library, where CE students may gather.

Wind Load – The pressure exerted by wind forces on the surfaces of the building, influencing structural design.

CHAPTER 2

Review Of Related Literature

This chapter presents reviews of the related literature and studies relevant to the present study. It includes the ideas, the finished thesis, generalizations or conclusions, methodologies, and others. Those included in this chapter help familiarize readers with information relevant to this study.

Foreign Literature

Educational institutions are among the major contributors to total energy consumption and greenhouse gas emissions worldwide, according to Abragam Siyon Sing M & M. Marsaline Beno (2024). With rising energy prices, it is vital to adopt an effective energy management approach that promotes sustainability and reduces environmental impact. They proposed an integrated framework that is scalable and can be implemented in an educational institution. They range from energy auditing to energy-efficient measures and the use of renewable energy technologies, such as solar panels, with results that demonstrate their effectiveness. The recommended measures enhance energy efficiency, and the integration of a renewable energy system meets the institution's annual energy demand. Accordingly, the LCOE of the system is $0.0496 per kWh, which reflects its cost-effectiveness. Also, the positive Net Present Value and Profitability Index confirm the economic feasibility of the investment. Moreover, the

proposed combined approach is expected to reduce CO2 emissions by 518 tons annually.

Structural integrity is a fundamental notion in civil engineering. According to Alireza Bahrami and Kenneth Imo-Imo Israel Eshiet (2023), besides preventing catastrophic failure in structures, it plays a vital role in ensuring the durability and low maintenance costs of a structure and can even affect its aesthetic value. In some cases, cracks in concrete not only lead to a loss of structural integrity but also accelerate the ingress of aggressive substances such as water, chloride, and carbon dioxide, resulting in further deterioration and increased maintenance costs. Similarly, visible cracks and deflections can reduce public acceptance of the structure. That is why they provide information on procedures for investigating and evaluating reinforced concrete structures, including non-destructive testing methods, structural health monitoring, and finite element analysis. Causes of failure: material quality, overloading, design flaws, environmental factors, and construction defects.

Based on Uranjek, Mojmir (2025), Structural monitoring aims to detect the possible progression of existing damage or the formation of new damage for various reasons, while strengthening measures aim to ensure structural integrity and an adequate level of seismic resistance for buildings. He described the current practice in the field in Slovenia and suggested combining the global calculation model with local failure mechanisms, and combining monitoring, structural investigations, and seismic resistance assessment.

In accordance with Gd Waldner India Pvt. Ltd. (2024), laboratory design and planning play pivotal roles in fostering innovation, efficiency, and safety. They suggest some flexible design trends that incorporate advanced technology, sustainability, and energy efficiency. That also has a collaborative space where students meet and share equipment, while ensuring compliance with biosafety protocols.

Hassan et al. (2024) analyze how alternative load-bearing structural systems can facilitate sustainability in the built environment. They argued that the selection of structural systems is an important factor in material consumption, carbon emissions, and construction cost, three important areas contributing to green building. Their case study presents an example of conventional load-bearing frame walls and continuous wall foundations being replaced by timber columns supported on separate footing pads, with reduced concrete and steel use, resulting in lower material costs and carbon emissions (Hassan & Rezaei, 2024). Their results highlight the possibility of both structural innovation in architectural form and structural design to create engineering decisions that do not otherwise align with environmental goals. This research contributes to the literature on sustainable building systems by showing that structural design is one of several strategic levers for achieving reduced resource use while improving economic efficiency in built construction.

Local Literature

According to Jie Ann Rizaba Belotindos and Leticia A. Cansancio (2024), library space is crucial for engaging users, especially in academic institutions. Academic libraries can thus significantly enhance students' overall engagement by creating

conducive environments. They surveyed 100 students, and the results indicated that a student's perception of the library's design influences user engagement. The library space, aesthetics, and atmosphere got the highest mean ratings.

As Rosalina Palanca-Tan (2024) stated, the Philippines has significant solar energy potential. Yet, we have few households with rooftop solar panels, despite their benefits in reducing electricity costs and contributing to the clean energy transition. She also suggests that increasing property value appreciation and enhancing roof durability could be emphasized in future marketing and public awareness campaigns to strengthen the case for RTSP adoption, with government help.

Billion Bricks (2022) stated that the energy scenario in the Philippines is characterized by growing electricity demand, and the search for renewable energy sources is a crucial step towards a sustainable future. In 2022, the Philippines generated over 24000 GWh from renewable resources. Since the Philippines is near the equator, we receive an average of 5 hours of sunlight per day, which is great, and we use it as an alternative power source. Promoting solar awareness drives can equip communities with the knowledge needed to embrace a sun-powered future, motivating transformation towards a net-zero, eco-friendly lifestyle.

In this study, Marcelino Lunag Jr. (2024) tests the performance of the Solar PV system at State Louis University using life-cycle assessment from manufacturing through its end stage. The result shows that solar PV is economical and environmentally beneficial; it takes 7 years to recover the investment and 2.22 years to achieve payback for greenhouse gas emissions from the panels, 93 percent lower

than with coal-fired power plants. This also indicates that the panels have annual CO2 emission savings of 278,369 kg.

According to Kevin Jeswani et al. (2022), the study presents a framework for assessing earthquake risk in portfolios. It meets the demands for an efficient, systematic way to evaluate vulnerabilities in large-scale infrastructure. Exposed asset data collection and organization form the backbone. It integrates multiple scales of vulnerability information. The framework leads up to decision-making for stakeholders. In particular, the benefit-cost analysis of seismic retrofitting is highlighted. Applied to over 1,000 public school buildings in Makati and Quezon City, Metro Manila, he demonstrates that this framework can deliver reliable regional seismic risk assessments and identify significant risk and cost drivers.

Foreign study

As Fahmy Saputri (2024) explains, the focus is on renewable power sources. It paid close attention to solar power and its role in reducing carbon emissions in urban areas. The study is clear in Building B at Universitas Multimedia Nusantara. Researchers aim to switch from regular grid electricity to alternative solar setups. They did this without losing any efficiency in the building's operations. To check things out, they ran tests on solar panels through Pvsyst software. These tests assumed no shadows around and panels facing north. In the end, the roof area and the fifth floor seemed like solid choices for installing the panels. Looking at energy data over three months, solar

power was poised to deliver real economic gains. The payback period for the investment was roughly 20 years.

According to Sampurna Dadi Riskiono, Lulud Oktaviani, and Fatimah Mulya Sari (2021), the fair distribution of power, especially electricity, remains a challenge in Mesuji Regency, Lampung. But the energy supply is still unstable, notwithstanding the government's intervention. Frequent power cuts are a serious concern, particularly in education, as they disrupt the functioning of communities that depend on power. Moreover, these days, schools are increasingly using technology to perform tutoring and administrative functions, such as issuing digital report cards. To remedy the situation, the School Solar Panel System (SSPS) is proposed as a sustainable solution that aims to provide a continuous power supply, enabling effective teaching and learning even during outages. The research was conducted at SD Negeri 4 Mesuji Timur, located at Kota, Terpadu Mandiri Street, Margo Mulyo Village, Mesuji Timur District, Mesuji Regency, Lampung. The school was chosen because of the problem the teachers were having.

As stated by Uci Mardiani (2025), assesses how the DTS laboratories are being utilized at Universitas Andalas in support of educational and research activities, both internally and externally. The following four important laboratories were selected for the study: Materials and Structures (LMS), Transportation and Highway Pavement Laboratory (LTJR), Soil Mechanics Laboratory (MEKTAN), and Fluid Mechanics and Hydraulics Laboratory (LMH). A descriptive qualitative approach was used. Data collection was conducted through interviews during visits to the Civil Engineering

laboratories at Gadjah Mada University and Bandung Institute of Technology—secondary data included practicum schedules used in the laboratories. The utilization rates differ significantly: 66.54% for LMS, 33.09% for LTJR, 80.46% for MEKTAN, and 85.71% for LMH. It is a very useful result for managers to use in developing further plans for infrastructure. However, there are shortcomings, such as uneven usage distribution and preparation times.

According to Marijana Hadzima-Nyarko, Naida Ademovic, and Marija Krajnovic (2021), safety is one of the most important features of a school building. Since a significant part of school spaces plays a major role in children's growth, architects, engineers, and scientists have been motivated to review current methods for the construction and upgrading of school buildings. Earthquake damage estimation is a helpful method of reducing the impact of earthquakes on materials. This paper will analyze the architectural and structural characteristics of a primary school building in Osijek, Croatia, and generate artificial accelerograms as input to nonlinear static and dynamic analyses to assess damage to the selected reinforced concrete school. Strong-motion simulation methods to evaluate the seismic vulnerability of structures are also referred to as theoretical approaches. Insights from researchers in each infrastructure area can serve as a guide to good renovation. Reconstruction needs to be grounded in sound science and have clear goals that align with users' needs.

According to Raunak Deswal and Deepak Verma(2025), provide a review of structural integrity and safety in buildings. They compile standards, plan practices, and address the challenges involved in creating long-term structure. The author has

highlighted the increasing number of fire incidents, human casualties, and property losses. This happening calls for a comprehensive approach to building security and a strong infrastructure with safe features. The paper analyses various national and international codes, comparing their guidelines for load factors and material behavior under pressure. The writer also identifies gaps in how these keys are implemented, noting that many facilities do not meet the ideal design-code conditions. To connect the study, this section helps with designing a laboratory, specifically in hazardous areas.

Local Study

Based on the study conducted by Arl Rey Canicula, Franz Aldrei Bayhon, and Joshua Bagaforo (2024), the study highlights issues in Badiangan, a town in Iloilo, specifically regarding public services and facilities for young people. They mention no real officer or storage for the Local Youth Development Council. The library is limited too. And the social hall has no seats. The author suggests the infrastructure of a three-storey facility. It would combine a Local Youth Development Center, a public library, and a lobby that actually works; the writer includes the plans for architecture, structure, electrical, plumbing, and fire protection. Everything follows Philippine building codes, like Canicula and the others say in 2024. In this paper, we focus on making it sustainable and tough against problems. The technical part covers soil checks, detailed cost estimates, project scheduling, and specifications. The site they picked is 309.75 square meters. Construction should take 201 calendar days. The estimated budget comes to PHP 15,611,240.37. The local government funds it, with

much help from private donations. The authors warn that prices for materials and labor need to be checked regularly due to inflation, and that construction waits until the Local Government Unit approves the design plan.

According to Aguilar et al. (2022), the researcher observed a strong push for a spot in the San Juan Parish area, in San Simon, Pampanga. The writer came up with the idea of a three-storey multi-purpose building, all part of the church of the poor program. It handles programs, storage, and places for people to meet up. The old cathedral setup could not keep up with all that. Their design pulled together elements of architecture, structural plans, electrical work, plumbing, and even cost estimates. The goal was an infrastructure that would work well and fit right in with the old look of the parish buildings. They thought the exterior would match the antique church style. It would blend with the nearby chapel, too, in a way. The study highlights the importance of choosing the right site, keeping options flexible for different uses, and considering disaster risks when making choices. This whole approach provides a comprehensive solution that covers solid structure, hooking up utilities, and makes it easy for the community to use. It adds to what we know in construction like this, in parishes and communities around the Philippines.

According to Mansala et al (2023), the writers focused on what the school at De La Paz Elementary really needed. Plus, it came up with a design for a multi-purpose hall to address some major infrastructure problems there. And not just for the institution. The whole barangay around it was dealing with shortages, too. The place has been struggling since 2012. No proper stage. No court for activities. Nothing like

a clinic or storage rooms either. So, many events end up in the hallways. And those get hit by rain or whatever weather comes along. The researchers suggested a setup that pulls together different spaces. Like a stage, a court, storage areas, and even a canteen. To check the structure, they ran an analysis in STAAD.Pro software. And they did some manual calculations on top of that. All to ensure it aligns with the 2015 National Structural Code of the Philippines. The hall does more than host academy stuff or group gatherings. It fits right in with handling risks from typhoons and earthquakes. Their work shows a good way to create institute facilities. Make them handle multiple uses. Build them tough. And keep the community in mind. To connect the study, this paper helps us improve the design of a multi-purpose structure and ensure structural safety using STAAD.

According to Agapito et al. (2025), this study shows the design and simulation of a three-storey, energy-sustainable multi-purpose academic building at Eastern Visayas State University, Ormoc City, Philippines. A recent paper on sustainable architecture highlights the importance of combining climate-responsive design ideas with simulation methods. It enhances the performance of any institution, especially within the tropics. As Garde and his colleagues showed pretty clearly in (2017), and Prianto and Depecker in (2002), passive cooling and natural ventilation reduce indoor heat. They improve thermal comfort in schools and the like. You see, computational tools for modeling airflow, heat patterns, and daylight are now quite common. These are Autodesk CFD and Revit, among others. In fact, it was Malkawi and Augenbroe who, in 2004, pointed out that these allow people to predict and adjust indoor air

quality more accurately. Hybrid renewable power setups, with the help of software such as HOMER Pro, were called by Lambert and others in 2006 a smart, inexpensive off-grid method in places around the same universities. Anyway, the present study at EVSU-Luna Campus fits into all this. We gathered together passive strategies, energy models, and structural sims to build a green, up-to-code school building. It takes what came before and adds a full framework that is easy to copy. Tailored for the Philippines, basically. It pushes the point that simulation-led, eco-smart plans matter big time for upcoming infrastructure setups.

Boquite et al. (2023) present a review of the role of public libraries in education, cultural development, and civic engagement, with particular relevance in developing municipalities. The researcher resolved the lack of public learning areas in Lambunao, Iloilo, by proposing a sustainable three-storey municipal library. Aside from enhancing green building features such as photovoltaic panels, rainwater catchment, and natural lighting, their design is architectural, structural, electrical, and plumbing in nature and follows national building codes. This is a model of infrastructure planning that fosters community education and awareness, relating environmental responsibility to functionality.

Synthesis of the Literature and Study

The review of related literature highlights critical issues and solutions in the design of a three-storey building with a solar panel, in particular of green infrastructure, including a library, a laboratory, and a multi-purpose hall. People back

then were not capable of using alternative energy, but as time went by, they became more able to harness natural sources of power. Adding this to the structure can enhance the library's functionality, as noted by Boquite et al. (2023). A year later, Beno et al. (2024) proposed a scalable, integrated framework and implemented it at an educational institution, measuring solar panel-generated renewable energy and its effectiveness for the institution.

The gathered studies from international and local sources provide a valuable understanding of building design and the effectiveness of solar panels. The previous studies were found to be highly significant and relevant to the current research. Based on the paper by Aguilar et al. (2022), Arl Rey Canicula et al. (2024) provide insights into designing a library and multi-purpose hall to ensure the structure's safety and functionality. Fahmy Saputri (2024) and Sampurna Dadi Riskiono et al. (2021) reviewed the sustainability and long-term use of solar panels in educational institutions, leading to effective ways of using an alternative source of energy.

CHAPTER 3

Research Methodology

This chapter focuses on the research method and procedures the researcher followed to conduct the study systematically. Specifically, this chapter explained the research design, the study's respondents, the sampling techniques, the instruments used, their construction, validation, administration, and retrieval, and the statistical treatment of the data used for accurate data analysis and interpretation.

Research Design

This descriptive quantitative method is used in this research to produce quantifiable information that will support the structural design of the proposed three-story Civil Engineering building at La Concepcion College in Kaypian. The study focuses on applying structural calculations, engineering codes, and architectural standards to create a safe, functional, and efficient academic environment. To ensure structural integrity, stability, and compliance with requirements, analysis of loads, simulations using software, and comparisons with the National Structural Code of the Philippines are performed.

Design Process

Design Planning

This design is in accordance with the NSCP and other relevant guidelines to ensure longevity, stability, and safety. Theoretical and practical learning can be provided through the inclusion of a multi-purpose hall, labs, and a library in the design. Planning will focus on usability, security, and accessibility by all users.

Site Analysis

The site at La Concepcion College P.E. Ground in Kaypian is assessed for environmental considerations, grading, access routes, and available space. The proposed three-storey Civil Engineering building will fit into the current campus layout. Open areas, pedestrian ways, and service access are designed for convenience and safety.

User Needs

The design meets the needs of students, instructors, and administrators in the field of civil engineering. It includes labs for practical learning in geotechnical, chemical, physical, hydraulic, and computer studies. The multi-purpose hall supports academic events and lectures. These facilities are adequate to meet the department's current enrollment needs and should accommodate future growth.

Design Tools and Software

AutoCAD is used for architectural layouts and 2D floor plans; STAAD Pro for structural analysis and design of beams, slabs, columns, and foundations; and SketchUp for 3D visualization in layout presentations. Excel is used in load calculations and cost estimates.

Sample and Population

The respondents are Civil Engineering students, faculty, and administrators at La Concepcion College. They are the main users of the proposed building, giving insights into functionality, accessibility, and learning needs.

Sampling Technique

The research applies purposive sampling. The participants selected are those directly involved in the Civil Engineering program. Their responses identify the space, design, and facility needs of the proposed three-storey building. This method ensures the data are relevant and accurate, reflecting the users' actual needs.

Research Instrument

This study will make use of the following instruments in collecting data for the design and evaluation of the proposed three-storey Civil Engineering building.

A. Design

2D and 3D models are developed for presenting the plan, layout, and visual form of the proposed structure. First, the floor plans and sections are prepared in AutoCAD, while 3D visualization in SketchUp enhances the presentation and enables spatial analysis.

B. Surveys

Surveys are to be distributed to all Civil Engineering students, faculty, and administrators of La Concepcion College. The survey gathers data regarding classroom space, laboratory accessibility, comfort, and facility needs for the design of the Library, Laboratories, and Multi-purpose Hall.

C. STAAD Pro

Structural analysis shall be performed using the provided program called STAAD Pro to check on beam, slab, column, and foundation strength and stability. Calculations include dead load, live load, wind load, and seismic load according to the National Structural Code of the Philippines.

D. Miniature Model

A scaled model of the proposed three-storey building is prepared to show the overall form, interior layout, and spatial arrangement. It helps visualize the connection between the library, laboratories, and multi-purpose hall.

Data Gathering

The data collection encompasses four major elements: questionnaires, structural design work, miniature modeling, and costing.

This questionnaire is designed to gather input from Civil Engineering students, faculty, and administrators at La Concepcion College. The questionnaire is prepared to ensure clarity and accuracy, thereby facilitating the easy recording of respondents' feedback and responses on general classroom spaces, laboratory accessibility, comfort, and the need for additional facilities such as a library and a multi-purpose hall. A combination of online and in person surveys was conducted to ensure the convenience and reliability of responses.

The structural design work collates the technical data necessary for the analysis. The architectural requirements are translated into detailed floor plans using AutoCAD. The load data, including dead load, live load, wind load, and seismic load, is computed in accordance with the National Structural Code of the Philippines. Furthermore, STAAD Pro and manual calculations are utilized to model and analyze beams, columns, slabs, and foundations. Results are compared with code requirements to confirm safety, stability, and efficiency.

The miniature model is a scaled representation of the proposed three-storey building, showing the exterior form, floor layouts, and internal arrangement to provide a clear view of how spaces for a library, laboratories, and multi-purposea hall are organized.

Finally, the costing stage assesses the design's financial viability. Microsoft Excel is utilized to compile data on material quantities, labor costs, and other construction expenses. This ensures that the building will not only be structurally sound but also cost-effective and practical to implement.

Statistical Tool

Percentage and Frequency Distribution

This method presents the demographic profile of the respondents. The data are grouped by age, sex, and role within the Civil Engineering department. Frequency indicates the number of respondents in a category, while its percentage is in relation to the total number of respondents. This will enable the researcher to outline the pattern and trend among the participants and present a clear view of the characteristics relevant to the participants of the study.

Chi-Square Test

The chi-square test is used to test whether there is a significant statistical relationship between categories. It provides an objective way of analyzing survey data to assess if the observed response varies significantly from what was expected. The findings will help verify the outcomes and ensure the reliability of the conclusions of this study.

Formula:

$$x^2 = \sum \frac{(O - E)^2}{E}$$

Where:

x^2 = chi-square, the test statistics

O = number of observed frequencies recorded

E = expected frequencies

Likert Scale and Weighted Mean

The Likert scale assesses respondents' perceptions and opinions regarding the proposed three-storey Civil Engineering building, which includes a library, laboratories, and a multi-purpose hall. This will address functionality, accessibility, safety, comfort, and adequacy of the classrooms, laboratories, and faculty rooms. This system quantifies respondents' agreement to provide measurable insight into the practicality and effectiveness of the proposed design.

Rate	Verbal Interpretation	Range
5	Strongly Agree	4.20 – 5.00
4	Agree	3.40 – 4.19
3	Neutral	2.60 – 3.39
2	Disagree	1.80 – 2.59
1	Strongly Disagree	1.00 – 1.79

Figure 3: *Likert scale*

Formula:

$$Weighted\ Mean\ = \frac{\sum(f\ \times\ w\ )}{Total\ Response}$$

where:

f = frequency of each response

w = weight assigned to each response